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ON THE NATURE OF EARLY-TYPE EMISSION LINE OBJECTS IN NGC6611

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Abstract. The number and the nature of emission line stars in the young open cluster NGC6611 is still the object of debates. Due to the presence of a strong and variable nebulosity in the cluster, the number of emission line stars is highly depending on the technique and the resolution used for the observations. Thanks to observations with the ESO-WFI, in slitless spectroscopic mode, and with the VLT-GIRAFFE we have been able to disentangle the circumstellar and nebular emissions. We confirm the small number of true emission line objects and we precise their nature: mainly Herbig Be stars.

1 Introduction

NGC6611 is a young open cluster with log(age) = 6.2 or 6.8, depending on the authors. According to Hillenbrand et al. (1993) and de Winter et al. (1997) it contains a great number of emission line stars (ELS), whereas Herbig & Dahm (2001) only found a small number. It is however worth noticing that the two first studies were carried out using slit spectrographs, while Herbig & Dahm (2001) used a slitless instrument not sensitive to the surrounding emission originating from the Eagle nebula.

In order to further investigate the occurence of emission line stars in NGC6611 and to determine the nature of objects, we used the Wide Field Imager (WFI) at ESO in slitless spectroscopic mode associated to a 200 nm passband Hα filter. We further also made use of the multi-object spectrograph GIRAFFE at the VLT in MEDUSA mode. The spectra obtained in this way allowed us: 1) to determine the stellar parameters, 2) to disentangle the circumstellar and nebular emissions, and 3) to determine the true nature of the targets.

2 Emission line stars

2.1 WFI observations

With WFI, we obtained ∼15000 spectra of the sources in NGC6611 and its surrounding field. Due to the fact that WFI in slitless mode is not sensitive to the ambient nebular emission, we listed the stars with and without circumstellar (CS) emission. However, this slitless mode does not allow the detection of faint CS emissions. A small number of ELS was identified and preselected for the VLT-GIRAFFE observations.

2.2 VLT-GIRAFFE observations

The 100 objects finally observed with GIRAFFE are shown in Fig. 1.

Among them, only 9 were identified as "true" CS ELS. The main part of the previously known ELS had their spectra contaminated by nebular emission, as shown in Figure 2 where the Hα regions obtained with WFI and GIRAFFE are displayed for two cases: W483, a true ELS, and W371, misidentified as ELS in previous slit spectroscopy.

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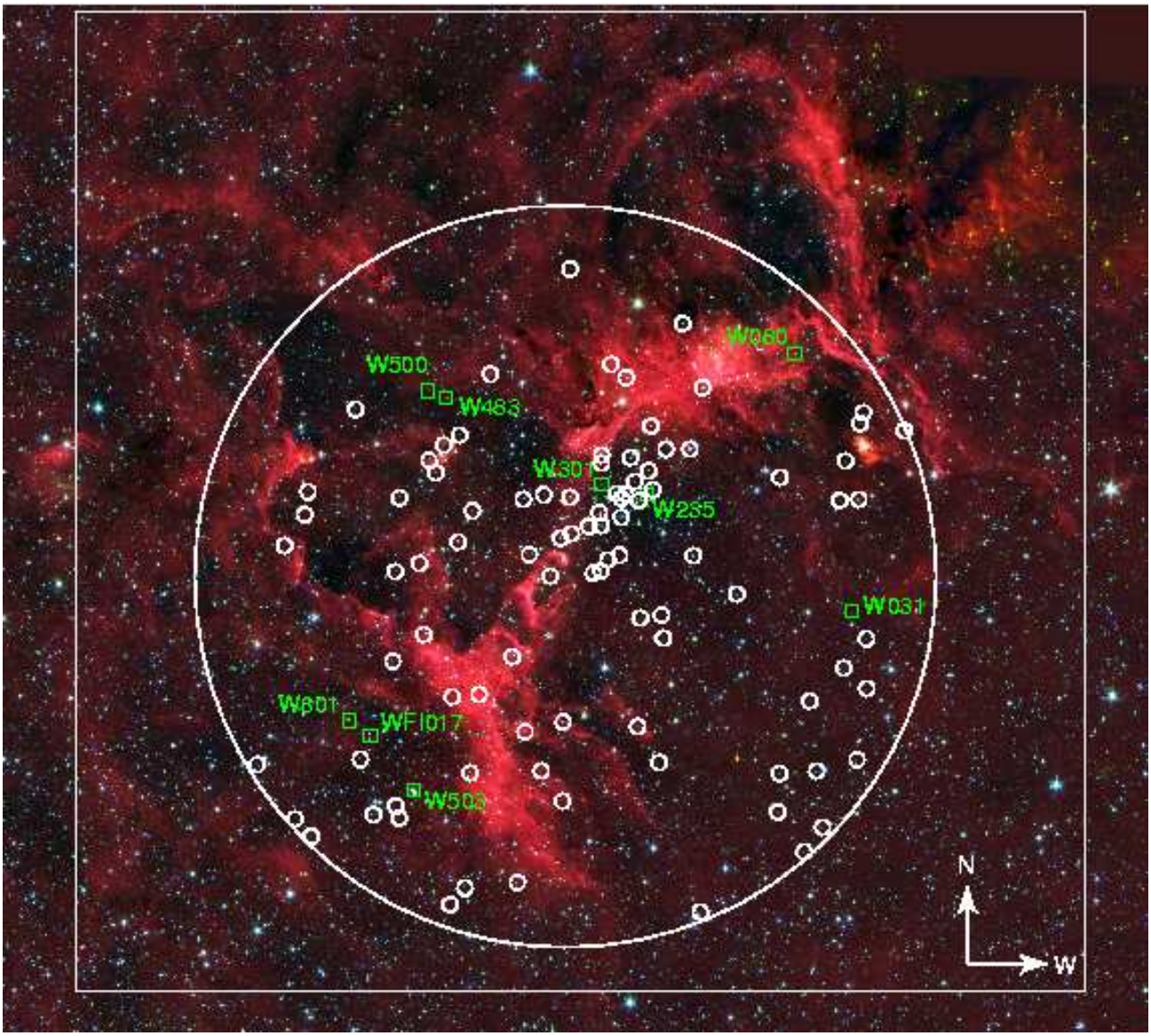

Fig. 1. Location of the stars observed with the VLT-GIRAFFE in the field of NGC6611. The image is a RGB mosaic with 3 channels of SPITZER (B: 3.6μm, G: 4.5μm, and R: 8μm). The small white circles are for the non-ELS stars, the green boxes are for the ELS stars. The large white circle shows the field of GIRAFFE and the large white box shows the field of the WFI-spectro. WFI017 stands for WFI[N6611]017.

3 Nature of NGC6611 stars

To investigate the nature of the stars observed with GIRAFFE, we determined their fundamental parameters and studied their spectral energy distributions (SED).

3.1 Fundamental parameters

We determined the fundamental parameters ($T_{\rm eff}$, $\log g$ and $V \sin i$) by fitting the GIRAFFE data with synthetic spectra following a procedure described in Frémat et al. (2006). Other parameters (mass, radius, age, luminosity) were then estimated by interpolation in theoretical evolutionary tracks computed for a solar metallicity (Schaller et al. 1992). A part of stars in the sample (mainly the massive stars) are young and lie close to the ZAMS. However, the analysis of our results demonstrates that a group of intermediate mass stars are too old

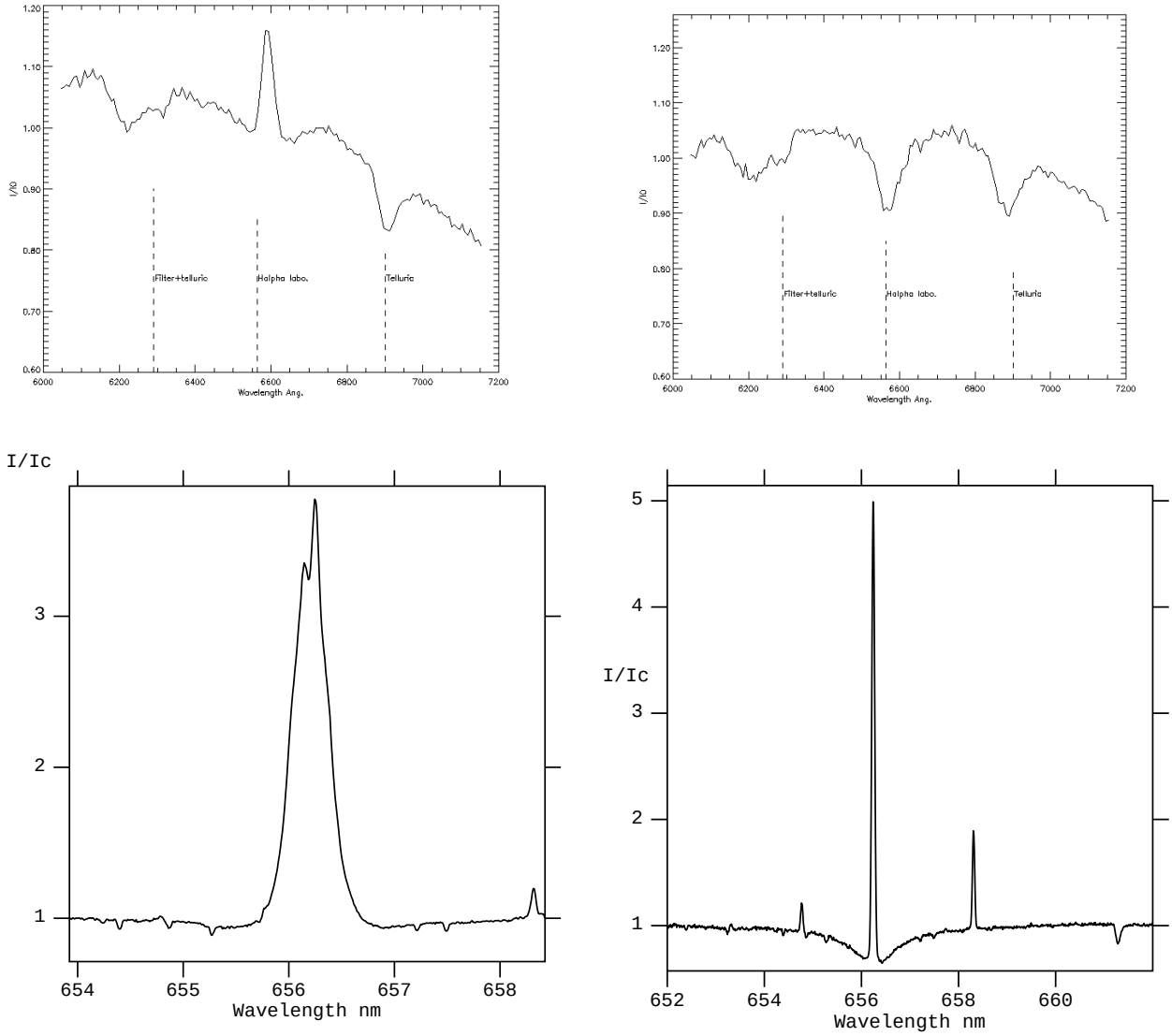

Fig. 2. Examples of WFI (upper panels) and GIRAFFE (lower panels) Hα spectra. W483 (left panels) displays a CS H*alpha* emission line while W371 (right panels) does not show any emission in WFI spectra but a nebular contamination in GIRAFFE spectra.

by comparison to the age of this star-formation region. Consequently, these stars must be, in fact, considered as pre-main sequence stars (PMS), which go to reach the ZAMS. We therefore re-estimated their age using the PMS evolutionary tracks computed by Palla & Stahler (1993) and Iben(1965).

3.2 Infrared study

The intrinsic interstellar reddening E(B-V) was measured for each star by means of the interstellar lines at 443.0 and 661.3 nm. It was used to correct the UBVI, JHK (2MASS survey), 3.6μm, 4.5μm, 5.7μm and 8μm (SPITZER) magnitudes. Each SED is normalized to the SED of a normal B star. For certain of non ELS stars, as well as for 5 of the ELS, the SED show an infrared excess. The origin of this more or less strong infrared excess could be a disk or cocoon around the central star. Such an infrared excess is compatible with Herbig Ae/Be stars or with PMS stars. This infrared study confirms the presence of PMS stars and allows to determine/confirm that the main part of the observed ELS are Herbig Ae/Be stars.

3.3 Nature of the true ELS

From the study of the Hα emission line, the fundamental parameters and the infrared excess, we concluded that:

- the stars WFI[N6611]017, W080, W235, W483, W500, W503 are Herbig Ae/Be stars.
- the star W031 is a possible Herbig Ae/Be star but a doubt remains.
- the star W301 is a classical Be star.

4 Conclusions

Slitless spectroscopy (WFI) as well as high resolution slit spectroscopy (VLT-GIRAFFE) confirm there are only few true emission line stars in NGC6611 as shown by Herbig & Dahm (2001). Thanks to the investigation of age and IR excess combined with spectral information we identified 8 Herbig Ae/Be stars and 1 possible classical Be star as well as several PMS stars without emission. Moreover, considering the more massive stars of the cluster which lie on the main sequence we estimated the age of NGC6611; we found log(age)=6.8 $\pm$0.2.

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